UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/612,482	07/02/2003	Daniel David Lecloux	UC0213 US NA4	3485

23906 7590 09/07/2005

E I DU PONT DE NEMOURS AND COMPANY
LEGAL PATENT RECORDS CENTER
BARLEY MILL PLAZA 25/1128
4417 LANCASTER PIKE
WILMINGTON, DE 19805

EXAMINER	
YAMNITZKY, MARIE ROSE	
ART UNIT	PAPER NUMBER
1774	

DATE MAILED: 09/07/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/612,482	LECLOUX ET AL.	
	Examiner	Art Unit	
	Marie R. Yamnitzky	1774	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 June 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-4,12-15 and 23* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-4,12-15 and 23* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper ~~No(s)/Mail Date~~ *rec'd 15 Dec 2003 and 26 Apr 2004.*
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

1. This Office action is in response to applicant's amendment and response to an election of species requirement, filed June 17, 2005.

Applicant's election without traverse of species (B)(i) in the reply filed on June 17, 2005 is acknowledged.

Applicant amends claims 13, 15 and 23, and cancels claims 5-11 and 16-22.

Claims 1-4, 12-15 and 23 are pending and read on the elected species.

2. The disclosure is objected to because of the following informalities:

The description of Figures 8, 9 and 11 as set forth on page 5 does not correspond to what is shown in these figures. Figure 8 shows Formula V. Figure 9 (Figures 9A-9AG) shows Formulae V(a) through V(ag). Formula VI(g) is labelled as Fig. 12G instead of Fig. 11 (or 11G). There is no Formula VI(l) or VI(m) in the figures although page 5, line 34 indicates that these formulae are in Figure 11.

Appropriate correction is required.

3. Claims 13-15 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The scope of an "alkylenearyl" and "alkyleneheteroaryl" as recited in claim 13, with claim 14 dependent therefrom, is not clear. This terminology implies that a group derived from an aliphatic hydrocarbon and having two points of attachment is attached via one point of

attachment to an aromatic hydrocarbon or heteroaromatic group, and the aromatic hydrocarbon or heteroaromatic group is attached to the ring at a R^4 or R^5 position. It is not clear what the group derived from an aliphatic hydrocarbon is attached to at the second point of attachment. It is not clear if this terminology may encompass alkylaryl and alkylheteroaryl groups which are not further substituted.

Claim 13 defines a, b, c and d as 0 or an integer, defines w as 0 or an integer from 1 through 4, and defines n as an integer. The term "integer" encompasses 0. Since 0 is recited separately from "an integer" in the definitions of a, b, c, d and w, it is not clear if applicant intends 0 to be outside the scope of "an integer" and thus not a possibility for n.

The second line of claim 15 recites, in part, "V(d) through V(i) and V(k) through V(ag)" but the formulae set forth after line 2 do not include V(f), V(s), V(aa), V(ab) or V(ac).

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 1, 3 and 23 are rejected under 35 U.S.C. 102(b) as being anticipated by Adachi et al. in *Journal of Applied Physics* 90(10), pp. 5048-5051 (Nov. 15, 2001).

Adachi et al. disclose organic light emitting devices comprising, in the order listed, an anode, a light emitting layer comprising $(ppy)_2Ir(acac)$, which is a cyclometalated complex of a transition metal, an electron transport layer consisting of Alq_3, and a cathode.

Figure 6 on page 5051 provides energy diagrams for the devices. As one of ordinary skill in the art would recognize, while the LUMO and HOMO levels are shown as positive values in the figure, they are actually negative values relative to the vacuum level. The cyclometalated complex in the prior art devices has a LUMO of –3.0eV and a HOMO of –5.6eV, the electron transport layer has a LUMO of –3.3eV and a HOMO of –6.0eV, and the cathode has a work function of –3.7eV. Thus, in the prior art devices, E_1-E_3 = 0.4eV, E_1-E_2 = –0.3eV and E_4-E_5 = 0.4eV, meeting provisos (1)-(3) as set forth in present claim 1 and proviso (3) as further limited by present claim 3.

6. Claim 4 is rejected under 35 U.S.C. 102(b) as being anticipated by Adachi et al. in *Journal of Applied Physics* 90(10), pp. 5048-5051 (Nov. 15, 2001), as applied to claim 1 above, as evidenced by Naka et al. in *Appl. Phys. Lett.* 76(2), pp. 197-199 (Jan. 10, 2000) or Redecker et al. in *Appl. Phys. Lett.* 75(1), pp. 109-111 (July 05, 1999).

The electron transport layer in Adachi's devices consists of Alq_3, and therefore inherently meets the electron mobility limitation set forth in present claim 4. As evidenced by Naka et al. or Redecker et al., Alq_3 has an electron mobility that is greater than the lower limit set in claim 4. See Fig. 3 on p. 198 of the article by Naka et al. See lines 7-8 in the second column on p. 111 of the article by Redecker et al.

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Adachi et al. in *Journal of Applied Physics* 90(10), pp. 5048-5051 (Nov. 15, 2001) as applied to claim 1 above, and further in view of Egusa et al. (US 5,294,810).

Present claim 2 requires E_1-E_2 to be at least slightly more than 0, whereas E_1-E_2 is slightly less than 0 in Adachi's devices. Adachi's devices can be expected to have a slight barrier to flow of electrons from the electron transport layer/material into the light emitting layer and cyclometallated complex of a transition metal. The E_1-E_2 relationship required by claim 2 is not expected to provide any barrier to flow of electrons from the electron transport and/or anti-quenching layer to the cyclometalated complex per se of the photoactive layer. (The examiner notes that since the photoactive layer may comprise components other than the cyclometalated complex that will affect the LUMO of the layer, the LUMO of the photoactive layer is not necessarily the same as the LUMO of the cyclometalated complex of a transition metal.)

The relative LUMO levels of the electron transporting layer and the cyclometalated complex in Adachi's devices are similar to that depicted for layers O_3 and O_2, respectively, in Fig. 18 and described in columns 19 and 20 of the Egusa patent. The relative LUMO levels of the electron transporting layer and the cyclometalated complex for the device of present claim 2

are similar to that depicted for layers O_2 and O_3, respectively, in Fig. 2 and described in column 6 of the Egusa patent.

It would have been obvious to one of ordinary skill in the art at the time of the invention, having knowledge in the art such as knowledge of the teachings of Egusa, that different combinations of light emissive materials and electron transporting materials could be used to alter the ability of electrons to traverse from the cathode into the light emissive layer/materials, and thus alter device performance characteristics. One of ordinary skill in the art at the time of the invention would have reasonably expected, for example, that lowering or eliminating a barrier to flow of electrons from an electron transporting layer into a light emissive material would lower the operating voltage for the device. It would have been within the level of ordinary skill of a worker in the art at the time of the invention to determine suitable and optimal combinations of electron transporting materials and light emissive materials so as to optimize device performance. One of ordinary skill in the art would have been motivated to utilize combinations of materials providing E_1-$E_2 > 0$ in order to improve the flow of electrons into the light emissive layer.

9. Claims 1-4, 12 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Li et al. (US 6,723,445 B2) in view of Egusa et al. (US 5,294,810).

Li et al. teach that quinoxaline derivatives can be used to form an electron injection/ transport layer in EL devices, and that the luminescent material in the emissive layer of the

device may be triplet emitter such as $Ir(ppy)_3$, which is a cyclometalated complex of a transition metal. For example, see Fig. 9, 10 and 11, and Examples 6 and 7 in columns 8 and 9.

Li et al. do not explicitly limit the relationship between the work function of the cathode and the LUMO and HOMO energy levels of the quinoxaline-containing layer and the luminescent material so as to meet present provisos (1)-(3).

Provisos (1)-(3) cover a variety of energy level relationships described in the Egusa patent. The relative LUMO levels of the electron transporting layer and the cyclometalated complex for the device of present claim 2 are similar to that depicted for layers O_2 and O_3, respectively, in Fig. 2 and described in column 6 of the Egusa patent. The relative HOMO levels of the electron transporting layer and the cyclometalated complex for the device of present claim 3 are similar to that depicted for layers O_2 and O_3, respectively, in Fig. 2 and described in column 6 of the Egusa patent.

It would have been obvious to one of ordinary skill in the art at the time of the invention, having knowledge in the art such as knowledge of the teachings of Egusa, that different combinations of light emissive materials and electron transporting materials could be used to alter the ability of electrons to traverse from the cathode into the light emissive layer/materials, and thus alter device performance characteristics. One of ordinary skill in the art at the time of the invention would have reasonably expected, for example, that lowering or eliminating a barrier to flow of electrons from an electron transporting layer into a light emissive material would lower the operating voltage for the device. One of ordinary skill in the art also would have known that the relationship between the work function of the cathode and the LUMO of the

electron transporting layer affects the turn-on voltage of the device and the flow of electrons from the cathode to the light emissive layer, and the relationship between the HOMO of the electron transporting layer and the HOMO of the light emissive material affects the flow of holes. It would have been within the level of ordinary skill of a worker in the art at the time of the invention to determine suitable and optimal combinations of cathode materials, electron transporting materials and light emissive materials so as to optimize device performance. Regarding claims 2 and 3, one of ordinary skill in the art would have been motivated to utilize combinations of materials providing E_1-$E_2 > 0$ in order to improve the flow of electrons into the light emissive layer, and to utilize combinations of materials providing E_4-$E_5 > 0$ in order to prevent the flow of holes out of the light emissive layer into the electron transporting layer.

With respect to present claim 4, Li et al. teach that the quinoxaline derivatives have good electron affinity, and the quinoxaline derivative utilized in Li's Examples 6 and 7 is said to have better electron injection and transporting properties than Alq_3. Alq_3 has an electron mobility higher than the lower limit set forth in claim 4. Since the quinoxaline derivative in Li's Examples 6 and 7 has better electron injection and transporting properties than Alq_3, it is reasonable to expect that the quinoxaline derivative has an electron mobility higher than the lower limit set forth in claim 4.

10. Claims 1-4, 12-14 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kamatani et al. (US 2002/0135292 A1) in view of Li et al. (US 6,723,445 B2) and Egusa et al. (US 5,294,810).

Kamatani et al. disclose the use quinoxaline derivatives in electron injection and/or transport layers in EL devices. For example, see paragraphs [0079]-[0087]. See the various compounds defined in Tables 5, 6, 7, 14 and 15 in which at least one of A and B is a_1 or a_2, with the formulae for a_1 and a_2 shown in Table 1 on page 5. Many of these compounds meet the limitations of the quinoxaline derivative of Formula V in present claims 13 and 14. Kamatani et al. teach various materials that may be used in the luminescence (photoactive) layer, but do not explicitly teach using a cyclometalated complex of a transition metal in the luminescence layer.

Li et al. teach that quinoxaline derivatives can be used to form an electron injection/ transport layer in EL devices, and that the luminescent material in the emissive layer of the device may be triplet emitter such as $Ir(ppy)_3$, which is a cyclometalated complex of a transition metal. For example, see Fig. 9, 10 and 11, and Examples 6 and 7 in columns 8 and 9.

It would have been an obvious modification to one of ordinary skill in the art at the time of the invention, having knowledge of the teachings of Li et al., to utilize known triplet emitters such as $Ir(ppy)_3$, in the luminescence layer of Kamatani's device. It was known in the art at the time of the invention that EL device efficiency can be improved by using a triplet emitter and, based on Li's disclosure, one of ordinary skill in the art would have reasonably expected that Kamatani's quinoxaline derivatives could be used in an electron injection/transport layer in a device utilizing a triplet emitter such as $Ir(ppy)_3$ in the luminescence layer.

Neither Kamatani et al. nor Li et al. explicitly limit the relationship between the work function of the cathode and the LUMO and HOMO energy levels of the quinoxaline-containing layer and the luminescent material so as to meet present provisos (1)-(3).

Provisos (1)-(3) cover a variety of energy level relationships described in the Egusa patent. The relative LUMO levels of the electron transporting layer and the cyclometalated complex for the device of present claim 2 are similar to that depicted for layers O_2 and O_3, respectively, in Fig. 2 and described in column 6 of the Egusa patent. The relative HOMO levels of the electron transporting layer and the cyclometalated complex for the device of present claim 3 are similar to that depicted for layers O_2 and O_3, respectively, in Fig. 2 and described in column 6 of the Egusa patent.

It would have been obvious to one of ordinary skill in the art at the time of the invention, having knowledge in the art such as knowledge of the teachings of Egusa, that different combinations of light emissive materials and electron transporting materials could be used to alter the ability of electrons to traverse from the cathode into the light emissive layer/materials, and thus alter device performance characteristics. One of ordinary skill in the art at the time of the invention would have reasonably expected, for example, that lowering or eliminating a barrier to flow of electrons from an electron transporting layer into a light emissive material would lower the operating voltage for the device. One of ordinary skill in the art also would have known that the relationship between the work function of the cathode and the LUMO of the electron transporting layer affects the turn-on voltage of the device and the flow of electrons from the cathode to the light emissive layer, and the relationship between the HOMO of the electron transporting layer and the HOMO of the light emissive material affects the flow of holes. It would have been within the level of ordinary skill of a worker in the art at the time of the invention to determine suitable and optimal combinations of cathode materials, electron

transporting materials and light emissive materials so as to optimize device performance. Regarding claims 2 and 3, one of ordinary skill in the art would have been motivated to utilize combinations of materials providing E_1-$E_2 > 0$ in order to improve the flow of electrons into the light-emissive layer, and to utilize combinations of materials providing E_4-$E_5 > 0$ in order to prevent the flow of holes out of the light-emissive layer into the electron-transporting layer.

With respect to present claim 4, Kamatani et al. teach that the chemical structure of the compounds can be optimized to optimize electron mobility (see paragraph [0051]). Alq_3, a material known in the art for its electron transporting capability, has an electron mobility higher than the lower limit set forth in claim 4. It would have been *prima facie* obvious to one of ordinary skill in the art at the time of the invention, to make and use quinoxaline derivatives as electron transporting materials having electron mobilities comparable to, or better than, conventional electron transporting materials such as Alq_3.

11. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington,* 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

12. Claims 1-4, 12-15 and 23 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 42-61 of copending Application No. 10/612,704. Although the conflicting claims are not identical, they are not patentably distinct from each other because both sets of claims encompass an electronic device such as a light-emitting diode, a light-emitting electrochemical cell, or a photodetector, wherein the electronic device comprises a photoactive layer and a second layer comprising a quinoxaline derivative.

The quinoxaline derivative required by copending claim 42 is the same as the quinoxaline derivative required by present claim 13, and copending claim 43 requires a subset of the quinoxaline derivatives required by present claim 14. Copending claim 50 limits the quinoxaline derivative to 32 specific compounds, 26 of which are the 26 specific compounds represented by the formula set forth in present claim 15.

The copending claims do not require the photoactive layer to comprise a cyclometalated complex of a transition metal complex and do not limit the work function, LUMO and HOMO energy levels as in present provisos (1)-(3), but it would have been within the level of ordinary skill of a worker in the art at the time of the invention to select suitable materials from known materials for use in the photoactive layer of the copending device claims, and to optimize device performance based on comparative energy levels of the components of the device.

This is a provisional obviousness-type double patenting rejection because the conflicting claims have not in fact been patented.

13. Miscellaneous:

Claim 1 and the specification use the unit "V" in reference to work function, LUMO and HOMO energy levels. The examiner notes that the unit for work function and these energy levels is typically "eV", and interprets "V" as meaning "eV" when used in reference to work function and LUMO and HOMO energy levels.

The paragraph bridging pages 6 and 7 of the specification defines "E_2" as the LUMO of the photoactive layer and "E_4" as the HOMO of the photoactive layer. Claim 1 defines "E_2" as the LUMO of a cyclometalated complex of a transition metal that is a component of the photoactive layer and "E_4" as the HOMO of the cyclometalated complex of a transition metal. Since the photoactive layer may comprise components other than the cyclometalated complex that will affect the LUMO and HOMO of the layer, the LUMO and HOMO of the photoactive layer is not necessarily the same as the LUMO and HOMO of the cyclometalated complex of a transition metal.

14. Any inquiry concerning this communication should be directed to Marie R. Yamnitzky at telephone number (571) 272-1531. The examiner works a flexible schedule but can generally be reached at this number from 6:30 a.m. to 4:00 p.m. Monday, Tuesday, Thursday and Friday, and every other Wednesday from 6:30 a.m. to 3:00 p.m.

The current fax number for all official faxes is (571) 273-8300. (Unofficial faxes to be sent directly to examiner Yamnitzky can be sent to (571) 273-1531.)

MRY
September 01, 2005

Marie R. Yamnitzky

MARIE YAMNITZKY
PRIMARY EXAMINER

1774